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厦门大学

硕 士 学 位 论 文

假俭草草坪抗旱节水及抗寒护绿的化学调控技术研究

The study of water-saving and green-maintaining technique by means of chemical regulation for *Eremochloa ophiurodes* turf management

李 雄

指导教师姓名： 胡 宏 友 讲师

专 业 名 称： 环 境 工 程

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摘 要

草坪草普遍蒸腾耗水量大，且暖季型草坪草不耐冬季低温，枯黄期长，这是草坪养护管理中存在的两个主要问题。本研究以园林上广泛应用的暖季型草坪草假俭草为材料，采用盆栽和野外实验相结合筛选高效抗旱及促越冬期生长的配方，为城市草坪草养护提供配套的节水、节能及提高景观质量的管理技术。

在假俭草抗旱节水技术的研究上，本文首先探讨了干旱胁迫下假俭草各生长生理指标动态变化。结果表明，干旱处理 10 d后，未喷施药剂的假俭草叶绿素含量急剧下降，叶片游离脯氨酸含量和可溶性糖含量迅速增加，膜脂过氧化产物MDA大量积累，开始呈现干旱胁迫临界期生理变化症状，而喷施外源药剂（水杨酸、CPPU）可使假俭草干旱胁迫的临界期由 10 d延长至 13-15 d，即浇水时间间隔延长 30-50%，这对于草坪草的节水灌溉十分有利；在此基础上，研究进一步选择壳聚糖、多效唑、水杨酸、CPPU、黄腐酸等 5 种外源药剂进行抗旱性比较试验，结果表明，在所选择的浓度范围内，壳聚糖处理组生物量最高，并具有最大的根冠比，且叶片游离脯氨酸和丙二醛（MDA）含量也处于较低水平，这表明壳聚糖提高假俭草抗旱性能要优于其他 4 种药剂。此外，通过抗旱机制的初步研究表明，壳聚糖是通过增强蛋白质的稳定性，提高抗氧化酶活性，减缓丙二醛的积累以及提高叶绿素含量等等途径来达到提高假俭草抗旱性的目的，其中，250 $mg \cdot L^{-1}$壳聚糖处理下的假俭草叶绿素含量及生长生物量较其他处理组高、MDA含量则相对最低，均接近或达到正常浇水处理组的水平。综合分析表明，对于暖季型假俭草草坪，按 400 $ml \cdot m^{-2}$喷施 250 $mg \cdot L^{-1}$壳聚糖溶液，可以使草坪正常浇水间隔时间延长 30-50%，能显著发挥抗旱节水效果。

在假俭草抗寒护绿技术研究上，利用$L_9(3^4)$正交试验设计方法，本文设计了植物生长调节剂、速效肥与有机肥 3 因子 3 水平正交混施试验处理越冬期假俭草。与清水对照相比，正交混施处理组假俭草叶面积指数、叶绿素含量、叶片游离脯氨酸和可溶性糖含量均显著提高，同时根部根系活力、叶片抗氧化酶系（SOD、POD、CAT）活性也显著增加，叶片丙二醛含量则显著降低。处理组整体上促进了假俭草越冬期生长及抗冷性能的提高，显著改善了其冬季景观效果。

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因子间极差分析表明，主效因子随生长和抗性指标的不同而存在差异，表明混施时各因子在保持假俭草草坪冬季良好生长、提高抗性生理功能上所起的作用具有互补性。综合各指标正交分析的结果，提出了冬季提高假俭草抗寒性的最优混施配方，即多效唑、三十烷醇、CPPU、尿素和壳聚糖分别按 300、2、20、1500 和 1000 $mg \cdot L^{-1}$配制成液肥按 200 $ml \cdot m^{-2}$叶面喷施。

关键词：假俭草　抗旱　抗寒　节水　护绿　化学调控

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Abstract

Turf often consumes large quantity of water through its strong leaf transpiration. Meanwhile, warm-season turfgrass is subjected to cold-stress, wither and turn yellow during winter. In order to solve these problems, this research foucus on exploring the corresponding techniques to reduce the water-consuming as well as to improve the overwintering landscape quality of urban gardening turf. *Eremochloa ophiuroides* (Munro.) Hack, one of the main warm-season turfgrass species has been now widely used in the urban gardening landscape, was selected as the study material for this research. Pot and field experiments were conducted to screen the corresponding chemical formula to improve the drought-resistance and cold-resistance of the warm-season turfgrass.

The water-saving technique for *E. ophiuroides* turf management was explored through a set of drought-stress experiments. Firstly, the results of the experiment for the study of danymic response of *E. ophiurodes* to drought showed that the physiological drought-stress indexes of the grass without exogenous reagents application would changed 10 days after simulated drought stress, for example, the chlorophyll content began to decrease significantly, and free proline and soluble sugar content began to increase rapidly, meanwhile, malondialdehyde (MDA) was also determined to accumulate in great quantity. However, for those treatments applied with exogenous reagents, the changes were observed 13-15 days after the same drought stress condition. It suggested that, the watering interval time could be increased by 30-50% through applying corresponding exogenous reagents, this is quite beneficial to water-saving irrigation of turfgrass. Secondly, five exogenous reagents, which are chitosan, paclobutrazol, salicylic acid, CPPU, fulvic acid were selected for a screening test, the results showed that, among the five reagents, the value of biomass and root-shoot ratio of *E. ophiuroides* treated with chitosan were higher, meanwhile, the contents of free proline and MDA were lower than those treated by other reagents. It suggested that, compared with the other four kinds of exogenous reagents, chitosan was better to improve drought-resistance of *E. ophiuroides*. Further study revealed the chlorophyll content and biomass of *E. ophiuroides* in 250 $mg \cdot L^{-1}$ chitosan treatment group was higher than those in 500 and

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1000 mg·L^{-1} chitosan treatment groups as well as the control, however, it was reversed for the MDA content. No significant differences of all the growth and physiological indexes were founded between the 250 mg·L^{-1} chitosan treatment and the normal watering treatment. It suggested that chitosan can improve the drought–resistant ability of *E. ophiuroides* by enhancing its protein stability, improving the activities of antioxidant enzymes (SOD, POD and CAT), reducing the accumulation of MDA. Overall, foliar application of 250 mg·L^{-1} chitosan solution with 400 ml·m^{-2} can improve the drought-resistance of *E. ophiuroides* significantly. Under the drought condition, the interval time of turf irrigation could be increased by 30-50% in comparasion with the control.

In the study of promoting growth and prolonging green-maintaining period of warm-season turfgrass, a field experiment was carried out to treat *E. ophiuroides* with plant growth regulators, fast-released fertilizers and organic fertilizers by means of $L_9(3^4)$ orthogonal test. Compared with the control, the levels of LAI, chlorophyll, free proline and soluble sugar in the leaves of the treatment groups significantly improved, as well as the root activities, the activities of antioxidant enzymes, however, the contents of MDA decreased significantly. The growth, cold-resistance and the landscape quality of the treatment groups significantly promoted. The results of range analysis showed that the main effective factor varied with test indexes, which meant that plant growth regulators and fertilizers are complementary to promote the growth and enhance the physiological functions of turfgrass during winter. To improve the integrated quality of *E. ophiuroides* during winter, an optimum formula was proposed through comprehensively analyzing the growth and cold-resistant indexes, that is: a liquid fertilizer, containing paclobutrazol, triacontanol, CPPU, urea and chitosan with their concentrations as 300, 2, 20, 1500, and 1000 mg·L^{-1} respectively, should be applied to the turf by foliage spray with 200 ml·m^{-2}.

Keywords: *Elemochloa ophiuroides*; Drought resistance; Cold resistance; Water-saving; Green-maintaining; Chemical regulation

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